CA

WP#109

AGRICULTURAL DEVELOPMENT SYSTEMS EGYPT PROJECT

UNIVERSITY OF CALIFORNIA, DAVIS

SAMPLING DESIGN FOR COMMODITY SYSTEMS ANALYSIS SURVEYS IN EGYPT

By
Hassien M. Abd-Samie
Amin A. Montaser
University of Azhar, Egypt

Economics

WORKING PAPER

USDA/EGYPT

SAMPLING DESIGN FOR COMMODITY SYSTEMS ANALYSIS SURVEYS IN EGYPT

By
Hassien M. Abd-Samie
Amin A. Montaser
University of Azhar, Egypt

Assistance from the Agricultural Development Systems Project of the University of California, Egyptian Ministry of Agriculture, and USAID, is gratefully acknowledged, but the author is soley responsible for the views expressed in this paper.

Economics
Working Paper Series
No. 107

January, 1983

Agricultural Development Systems:
Egypt Project
University of California
Davis, Ca 95616

SAMPLING DESIGN FOR COMMODITY SYSTEM ANALYSIS SURVEYS IN EGYPT

The aim of this paper is to outline a recommended sampling design for surveys of commodity system analysis in developing countries such as Egypt. It also provides a reasonable estimation for a sample size can be utilized in this sort of analysis under the Egyptian circumstances. Data generated by this design should be sufficient for overall commodity systems, as well as, some other studies.

In Commodity System analysis, it is necessary to provide a taxonomy to examine the dynamic forces that influence selected commodity systems, and at the same time there is a need to study the interrelated economic and social factors that affect decisions made at various levels of the vertical production - marketing system (1, 7, 11, 12, 16).[1]

This paper deals with the sampling design for the commodity system analysis of wheat and potatoes. To study the above points it is very important to draw a sample from the population (farmers or farms) with respect to some variables.

---

[1] Numbers in parenthesis refer to literature cited in the bibliography.

Although other survey designs are available, a stratifed, two-stage cluster sampling procedure is strongly recommended to generate survey data on commodity system analysis.[1] This sampling design calls for an initial step of dividing the population into subpopulations or strata. These subpopulations are nonoverlapping, and to gether they comprise the whole of the population (5, 6). Within each stratum or subpopulation, a separate selection can be made by chosing a predetermined number of cluster primary sampling units with respect to some pre-established selection probabilities (5, 6, 9). At last, a particular number of farmers (elementary sampling units) are randomly selected to be studied in details. This sampling design will now be discussed in more detail.

The Stratification Justification

Stratification is a technique of dividing the heterogeneous population into subpopulations, or strata, each of which

---

[1] Other survey designs, such as simple random sampling, stratified random sampling, systematic sampling, single stage cluster sampling, are discussed in details in various sampling techniques texts (3, 6, 8, 9, 14, 15).
The stratified two-stage cluster sampling procedure are common used in most farm surveys in Africa, such as the studies of David Norman, 1973, and Dunstan Spencer, 1972, in Zaire, Nigeria and Sierra Leone, respectively (10, 13).

is internally homogenous with respect to some important variables in the study. Otherwords, the strata are chosen in such way variations between strata are as large as possible and in turn, variations within strata are minimized. Hence a gain in precision can be guaranteed by such procedure[1] (4, 6, 8, 10). As a result of gain in precision, the required sample size and the costs of the survey can be minimized. The gain in precision level depends on the chosen stratification variable, which in practice, is usually different from the estimation variables.[2] By drawing a small sample from each stratum, subpopulation, precise estimates of any stratum can be obtained, and hence, precise estimates of the whole population can be derived by

---

[1] Precision refers to the deviation size from the sample mean.

[2] The stratification variables may be natural such as soil type, economic such as agricultural productivity, area planted, crop patterns, labor (Familly babor or off farm labor), income, or social such as land/resident (rural or urban).

combining these estimates into it.[1]

---

[1] Specifically (6) :
The stratum is denoted with the suffix h, and the unit within the stratum is denoted with i. The following symbols all refer to stratum h,

N_h — total number of units

n_h — number of units in sample

y_{hi} — value obatined for the i th unit

$W_h = \frac{N_h}{N}$ — stratum weight

$F_h = \frac{n_h}{N_h}$ — sampling fraction in the stratum

$$\bar{Y}_h = \frac{\sum_{i=1}^{N_h} y_{hi}}{N_h}$$ — true mean

$$y_h = \frac{\sum_{i=1}^{n_h} y_{hi}}{n_h}$$ — sample mean

$$S_h^2 = \frac{\sum_{i=1}^{N_h} (y_{hi} - \bar{Y}_h)^2}{N_h - 1}$$ — true variance

$$\bar{y}_{st} = \frac{\sum_{h=1}^{L} N_h \bar{y}_h}{N} = \sum_{h=1}^{L} W_h \bar{y}_h$$ where

$\bar{y}_{st}$ is the estimate used in stratified sampling for the population mean per unit (st for stralified) where $N \equiv N_1 + N_2 + \cdots N_L$. In general $\bar{y}_{st}$ does not equal sample mean $\bar{y}$ where $^2 \approx$

Any way, although the stratified sampling design is more complicated in its calculations than the random sampling designs calculations it enables the researcher to foucs his research effort on a smaller sample.

Regarding the wheat and potatoes systems analysis the agricultural productivity (yield) is recommended as a stratification variable. This selection is really important particularly if the commodity system analysis will be studied from the decision making approach.[1] In this case the agricultural productivity variable will be considered a given. That enables researcher to study the unit profitability and in turn interpreates some important decisions such as, the decision to produce (or not to produce) wheat or potatoes, the decision to increase (or to decrease) area planted, the decision to

---

$\approx \bar{y} = \frac{\sum_{h=1}^{L} n_h \bar{y}_h}{n}$ because in $\bar{y}_{st}$ the estimates from the individual strata receive there correct weights N_h/N.
So $\bar{y}$ coincides with $\bar{y}_{st}$ provided that in every stratum

$$\frac{n_h}{n} = \frac{N_h}{N} \quad \text{or} \quad \frac{n_h}{N_h} = \frac{n}{N}$$

So the sampling fraction is the same in all strate. This which is called the stratification with proportional allocation of the n_h. It gives a self-weighting sample. In case of numerous estmates have to be made, a self-weighting sample is recommended as a time saving.

[1] If a model of industrial organization analysis be used in analizing the commodity system, the number of farmers, first handler, whole saler, processor, and/or retailer are recommended as stratification variables (11).

alter the planted crop with some other crops, and the limitation of this decision, the extend which farmer be willing to plant crop in rented land, the decision to hire off-farm labor for farm operations particularly in harvesting time, the decision to use insecticide and pesticide and the level of its usage (2).

The Clustering Justification

Clustering is a technique of dividing the area under study to a sampling units (primary units), which each unit of them consists of a group or cluster of smaller units (elementary units). There are two main reasons for the application of cluster sampling in such study. In Egypt, as most developing countries, it is rarely to find a reliable list of the elements in the population available, and that it would be prohibitively expensive to construct such a list. Specifically there are no complete and up-to-date lists of potatoes farmers (farms) in any large geographic region such as governorates. From maps of country or lists of centers withen each governorate, however, Egypt can be divided into centers in the rural areas. Even when a list of farmers (farms) is avialable, economic considerations may point to the choice of a

large cluster unit (governorate or markaz). Although a small unit (farmer or farm) usually gives more precise results than a large unit,[1] the field costs are incurred in locating small units (a large number of farmers) and in travel among them would be greater than in locating large units (a small number of centers) and visiting all the farmers in these large units. If costs are weighted against precision, the larger unit may prove superior. Any way the rule of selecting between two types or sizes of units is to select the unit that gives the smaller variance for a given cost for a prescribed variance.

In this sampling design the entire population, all of the Egyptian centers which plant wheat, are divided into strata, so that separate selections can be made in each stratum. In the first sampling procedure, a predetermined number of centers (clusters) are chosen within each stratum according to some pre-established selection probabilities. In the second

---

[1] For instance, if a simple random sample of 1000 farms covers the whole country be drawn, it would be more evenly than 50 centers containing an average of 20 farms per center (6).

stage, a fixed number of farmer are randomly selected for detailed study.[1]

Using centers as clusters is appropriate in this case because there are no lists of wheat or potatoes farmers or farms available in the Egyptian governorates level. Also using the yield average in centers level instead of governorates level as stratified variable may produce a gain in

---

[1] The following notation is used in estimating variance of the estimated mean in this study (6).

y_{ij} = value obtained for the $_j$th farmer in the $_i$th wheat or potatoes center (markaz)

$$\bar{y}_i = \sum_{j=1}^{m} \frac{y_{ij}}{m}$$ sample mean per farmer in the $_i$th center

$$\bar{\bar{y}} \sum_{i=1}^{n} \frac{\bar{y}_i}{n}$$ over-all sample mean per farmer

$$S_1^2 = \frac{\sum_{i=1}^{N} (\bar{Y}_i - \bar{\bar{Y}})^2}{N - 1}$$ variance among centers mean

$$S_2^2 = \frac{\sum_{i=1}^{N} \sum_{j=1}^{M} (y_{ij} - \bar{y}_i)^2}{N (M - 1)}$$ variance among farmers within centers.

Where N and M are numbers of centers and farmers in the population respectively, and n and m are numbers of centers and farmers in the sample respectively.

precision in the estimates of characteristics of the whole population, and in turn the sample estimation of the population will be more precious.[1]

To stratify the population of wheat and potatoes centers in Egypt, data of crop yield (ardeb per feddan) for both crops for all Egyptian centers were collected. Regarding the wheat crop, data of yield average were calculated for 132 centers in 20 Egyptian governorates.[2] These centers were stratified to four strata as shown in table 1. The potatoes crop strata were obtained in the same manner of wheat crop mentioned previously. Data of potatoes yield average for 122 Egyption center in 20 governorates were obtained.[3] These centers were stratified to four strata as shown in table 2.

---

[1] The unbiased estimate of the sample estimation of the variance $V(\bar{\bar{y}})$ is $v(\bar{\bar{y}})$ where

$$v(\bar{\bar{y}}) = \frac{1 - \left[\frac{n}{N}\right]}{n} s_1^2 + \frac{\left[1 - \left(\frac{m}{M}\right)\right]\left[\frac{n}{N}\right]}{mn} S_2^2 \text{ and}$$

$$s_1^2 = \frac{\sum_i^n (\bar{y}_i - \bar{\bar{y}})^2}{n - 1}$$

$$S_2^2 = \frac{\sum_i^n \sum_j^m (y_{ij} - \bar{y}_i)^2}{n\,(m - 1)}$$

[2] The average for each crop yield was calculated from the crop yield data of years 78 - 1980. See table 1 in the appendix.

[3] See table 2 in the appendix.

Table 1
The wheat statistical strata by centers (marakez) with respect to yield, 1978 - 1980 average

Stratum number	Yield level (ardeb per feddan)	Centers	Number of Centers
1	Less than 8	Noqadh(A)[1], Brolos(K), Kantra Gharb(M), Awlad Touq(H), Abou Tesht(A), Souhag(H), Qouse(A), Mounshaah(H), Nagy Hamady(A), Saqeltah(H), Samta(F), Abou Homos(B), Maraghah(H), Heseniah(S), Deshna(A), Gerga(H), Essna(A), Tahta(H), Qenaa(A), Manzalah(D), Geheenah(H), Fashn(F), Tel El-Keber(M), Armant(A), Luxor(A), Rasheed(B), Alexandria(X).	27
2	8 to less than 9	Edfo(W), Kafr Saad(T), Baliana(H), Temma(O), Sohag(H), Sedy Salem(K), Ehnasia(F), Abou Al-Matamer(B), Dierb Negm(S), Delengat(B), Beba(F), Ebshway(O), Khankah(L), Kom ombo(W), Samanood(G), Bosh(F), Mansourh(D), Hosh Issa(B), Foah(K), Esmaliah(M), Asyut(Y), Dekrns(D), Giza(Z).	23

[1] Letters in parenthesis refer to governorates cited in the appendix.

Table 1 (Continued)
The wheat statistical strata by centers (marakez) with respect to yield, 1978 - 1980 average

Stratum number	Yield level (ardeb per feddan)	Centers	Number of Centers
3	9 to less than 10	Mattay(E), Kafr Al-Sheikh(K), Bany Mazar(E), Faqous(S), Abnoub(Y), Sedffa(Y), Saff(Z), Adwah(E), Metobas(K), Kafr Sakr(S), Wasta(F), Qeleen(K), Talla(N), Deer Moass(E), Etssa(O), Abou Hamad(S), Al-Senbelawen(D), Bialla(K), Maghagha(E), Talkha(D), Bagour(N), Kotoor(G), Sherbeen(D), Qousiah(Y), Sheben Kanater(L), Berket El-Sabi(N), Beny Souef(F), Badary(Y), Manfalout(Y), Abou Keber(S), Desouq(K) Fayed(M), Senoures(O), Rahmaniah(B), Belqas(D), Akhmem(H), Ghanayem(Y), Damanhour(B), Kafr El-Dawar(B), Sheben El-Kom(N), Fayom(O), Mehala El-Kobra(G), Damietta(T), Aswan(W) Suez(U), Maadi(C), Sahel Selem(Y), Mahmodiah(B).	48
4	10 or more	Agga(D), Aiaat(Z), Itay Barod(B), Qoesna(N), Shobra Kheet(B), Shohada(N), Dayrout(Y), Menia El-Qamh(S), Ashmoun(N), Santa(G), Kom Hamada(B), Embaba(Z), Samalout(E), Abou Qorqas(E), Badrashen(Z), Meet Ghamr(D), Bassioun(G), Belbes(S), Abou Teeg(Y), Kafr El-Zyat(G), Zefta(G), Hehia(S) Banha(L), Kanater Al-Khairia(L), Mallawy(E), Zagazig(S), Menia(E), Qalub(L), Mataria(C), Tanta(G), Kafr Shokr(L), Toukh(L), Faraskour(T), Menouf(N).	34

Table 2
The Potatoes Statistical Strata By Centers (Marakez)
with Respect to Yield, 1978 - 1980 average

Stratum number	Yield level (Ton per Feddan).	Centers	Number of Centers
1	Less than 6.50	Bialla(K), Abou Al-Matamer(B), Mataria(C), Hosh Issa(B), Adwah(E), Etssa(O), Kafr El-Dawar(B), Abou Homos(B), Fayom(O), Alexandria(X), Ehnasia(F), Abou Tesht(A), Nagy Hamady(A), Manzalah(D), Kom ombo(W), Talla(N), Kafr Al-Sheikh(K), Matay(E), Abou-Hamad(S), Qeleen(K), Kom Hamada(B), Sheben El Kom(N), Sedy Salem(K), Qoesna(N), Belqas(D), Mehala El-Kobra(G), Temma(O), Kantra Gharb(M), Menouf(N), Beny Souef(F), Damanhour(B), Aswan(W), Tanta(G), Ashmoun(N), Samalout(E), Hamol(K).	36
2	6.50 to less than 7.50	Bany Mazar(E), Bosh(F), Mallawy(E), Deshna(A), Desouq(K), Kotoor(G), Fayed(M), Dekrns(D), Foah(K), Bassioun(G), Menia(E), Deer Moass(E), Kafr Saad(T), Mahmodiah(B), Wasta(F), Metobas(K), Talkha(D), Abou Qorqas(E), Esmailiah(M), Mansourah(D), Maghagha(E), Santa(G), Berket El Sabi(N), Ebshway(O), Senoures(O), Rahmaniah(B), Delngat(B), Shohada(N), Suez(U), Qenna(A), Kanater Al-Khairia(L), Tel El-Keber(M), Meet Khamr(D), Kafr El-Zyat(G), Beba(F), Kafr Shokr(L).	36

Table 2 (Continued)
The Potatoes Statistical Strata by Centers (Marakez)
with Respect to Yield, 1978 - 1980 average

Stratum number	Yield level (Ton per Feddan)	Centers	Number of Centers
3	7.5 to less than 8.5	Samta(F), Senbelawen(D), Fashin(F), Zefta(G), Embaba(Z), Itay El-Barod(B), Damietta(T), Bagour(N), Shobra Kheet(B), Faqous(S), Khanka(L), Menia El-Qamh(S), Agga(D), Badrashen(Z), Sherbeen(D), Saff(Z), Dayrout(Y), Sheben El-Kanater(L), Edfo(W), Toukh(L), Qalub(L), Hehia(S).	22
4	8.5 or more	Abou Keber(S), Banha(L), Heseniah(S), Dierb Negm(S), Kafr Sakr(S), Belbes(S), Abnoub(Y), Rasheed(B), Manfalout(Y), Zagazeg(S), Aiaat(Z), Faraskour(T), Maadi(C), Qousiah(Y), Badary(Y), Giza(Z), Mounshaah(H), Sahel Selem(Y), Tumma(H), Samanood(G), Akhmem(H), Gerga(H), Saqeltah(H), Maraghah(H), Baleena(H), Awlad Touq(H), Sohag(H), Geheenah(H).	28

Sample Size

Now, the important question is how we can determine the sample size that would minimize sampling errors from sample surveys? to do so, the following three kinds of information are required :

A- The size of the available budget.

B- The variance estimates of the key variables to be enalyzed.

C- The desired precision level for the variables being estimated.

The critical economic question, however, is how we get the most for our mony. The details concerning these three kinds of information will now be discussed in the following subsection.

The available budget is the most important determining factor. For instance, most farm-level surveys in Africa have based their sample size on available budget. The overall budeget, as well as information about its constituent parts are required in this matter, particularly if a two-stage sampling procedure is utilized. Specifically, information on the cost of obtaining information from each center (C_c) and the cost of collecting data from each farmer within each

selected center (C_F) should be obtained.[1] Given the overall budget, C_f is necessary for determining the overall sample size of farmers, while C_c is necessary for determining the required number of centers to be sampled.

The sample size may be selected to minimize $V(\bar{y})$ for a specified cost of taking the sample or to minimize the cost for a specified value of $V(\bar{y})$.

The simplest cost function is of the form

$$C_T = C_X + C_V$$

Where:

C_T = total sampling cost

C_X = overhead cost

C_V = variable cost

Thus :

$$C_T = C_x + \sum_{h=1}^{L} C_c\, n_i + \sum_{h=1}^{L} \sum_{i=1}^{n} \sum_{j=1}^{m} C_F\, m$$

C_c and C_f are assumed to be constant across strata.[2]

---

[1] In more complicated formulas, however, the $\frac{C_c}{C_F}$ ratio is utilized for determining the number of farmers to be sampled from each center.

[2] C_c and C_f are assumed to be the same across Egypt. If travel costs among Egyptian centers are substantial, empirical and mathematical studies suggest that travel costs are better represented by the expression $\sum t_h \sqrt{n_h}$ where t_h is the travel cost per center.

The second component of cost $\sum_{h=1}^{L} C_c\, n_i$ is proportional to the number of centers in the sample ; the thired one $\sum_{h=1}^{L} \sum_{i=1}^{n} \sum_{j=1}^{m} C_f\, m$ is proportional to the total number of farmers. In this case $V(\bar{\bar{y}})$ may be written as

$$V(\bar{\bar{y}}) = \frac{1}{n}\left(S_1^2 - \frac{S_2^2}{M}\right) + \frac{1}{mn} S_2^2 - \frac{1}{N} S_1^2$$

To calculate costs of data collection for such study, both fixed costs and variable costs should be taken in account. The cost items can be as follows:

Firstly : Fixed costs

a. Salary of research fellow(s), research assistant(s). and field supervisor(s).

b. Air transportation if any.

c. Typewriter, duplicating machine salary.

d. Auto drivers salary.

e. Vehicle costs.

Secondly : Variable cost:

a. Costs of enumerating the sampled wheat or potatoes centers = $n\, C_c$.[1]

---

[1] C_c is the average cost of obtaining information from each center. It is made up of the following : Costs of stationary, enumerators salary while in training for farmers listing in each center, enumerators salary during the period of farmers listing, enumerators per diem during the period of farmers listing.

b. Costs of enumerating the sampled wheat or potatoes farmers = m. C_f.[1]

Finally : Total sample costs equals fixed costs plus variable costs.

Data on the variance estimates of the key variables of interest are needed. These key variable may include output, value added, profits, labor wag, machinery inventory. In Egypt, as many developing countries, these estimates are generally unknown in advance. In order to obtain a close estimation, a pilot study is suggested to be undertaken.[2] This pilot study should be undertaken on a stratum by stratum basis. From each stratum, $\acute{n}$ which is the number of wheat or potatoes centers, are chosen, with $\acute{m}$, which is the number of wheat or potatoes farmers taken from each center. This pilot study should be according to the stratified nature of the recommended sampling design. In this study the labor wag per day, displayed the largest variability. Therefore it is advisable to focus on this variable in the pilot study, because the

---

[1] C_f is the average cost of obtaining information from each farmer. It is made up of the following:

Costs of the enumerator while in training, enumerators salary while collecting data from the farmers, paper costs per farmer, costs of clipboard, raincoat and handbag per farmer. Costs of editing and coding questionnaire per farmer, costs of keypunching per farmer.

[2] The pilot study is required for obtaining variance estimates, and at the same time it is also suitable for pre-testing questionnaires and determining the nonresponse rate, and the rate of poor quality data.

Sample size dictated by its variance estimate ensures that the precision of the other variables will be even higher.

Finally, the desired precision level for the variable being estimated should be specified. To specify this precision level, two decisions must be made. The first decision relates to margin of error around the means estimate of the variables under consideration, and the second relates to the probability that the actual error is larger than the specified margin of error. After the level of precision be determined, it would be incorporated in the estimation formula. The precision level in sample surveys is very important for both the expected sample sizes and consequently, the variable costs of field surveys. There are, in fact important tradeoffs between the desired level of precision and the costs of data collection.

Although deferent margins of error can be specified, the ultimate use of the survey results determines the margin of error that can be tolerated. Generally, in most socio-ecenomic surveys, a maximum of 10 percent margin of error on sample estimates, is considered adequate. Any way, to reduce the margin of error by half both the sample size and variable costs of field surveys have to almost quadruple.

The probability level assumed in this kind of surveys is usually either 5 percent or 1 percent. For the purpose of this study, 5 percent level is assumed as probability level. Since $\alpha = .05$[1], T value of the normal distribution corresponding to = .05 is 1.96.

and the desired variance estimate $V = \frac{d^2}{t^2}$.

Where:

d = margin of error (assumed to be 10 percent).

t = the value assumed is 1.96 or approximataly 2.0

So the assumed fixed variance for this study is

$$V = \frac{(.1)^2}{(1.96)^2} = \frac{.01}{3.84} \doteq .0026$$

The effects of level of precision on sample size can be shown from the following formula:

$$n = \frac{\left[\sum_{h=1}^{L} \hat{W}_h \hat{S}_h \sqrt{C_F}\right]\left[\sum_{h=1}^{L} \hat{W}_h \hat{S}_h \sqrt{C_F}\right]}{V + \frac{1}{N}\left[\sum_{h=1}^{L} \hat{W}_h \hat{S}_h^2\right]}$$

Where:

n = Sample size of wheat or potatoes farmers.

$\hat{W}_h = \frac{\hat{N}_h}{\hat{N}}$

$\hat{N}_h$ = estimated total number of farmers in the n^{th} stratum.

---

[1] The risk we are prepared to take for which the actual error is greater than the specified degree of error.

N = estimated total number of farmers in the population.

C_f = cost of obtaining information from one farmer in the stratum (for the purpose of this study it is assumed to be 4 L.E).

$\hat{S}_h^2$ = estimates stratum variance estimate for the measurable variable of interest (labor wag per day).

By applying this formula the sample size equals 3066 farmers.

By ignoring the assumed fixed variance for this study, the formula recommended for sample size depends upon the variable cost.

Since $C_T = C_x + C_v$ So

$$n = \frac{\left[C_T - C_x\right]\left[\sum_{h=1}^{L} (\hat{N}_h \hat{S}_h / \sqrt{C_F})\right]}{\sum_{h=1}^{L} (\hat{N}_h \hat{S}_h \sqrt{C_F})}$$

and $$n_h = n\left[\frac{\hat{N}_h \hat{S}_h / \sqrt{C_F}}{\sum_{h=1}^{L} (\hat{N}_h \hat{S}_h / \sqrt{C_F})}\right]$$

Where :

n = the sample size of farmers.

n_h = the sample size of farmers allocated to each stratum.

$\hat{N}_h$ = an estimate of the population size of farmers for each stratum.

$\hat{S}_h$ = an estimate of the population variance of the n^{th} stratum.

L = the number of strata

The total number of centers can be estimated from a simple cost function as follows :

$$C_h = C_c\, m_h + C_F\, n_h$$

Where:

C_h = total field cost of the survey in the n^{th} stratum

n_h = total number of farmers to be sampled in the n^{th} stratum.

m_h = total number of wheat or potatoes centers to be sampled in the n^{th} stratum.

By applying this formula and assuming the variable cost equals 10,000 L.E, the sample size equals 2500 farmers.

So, it can be stated that, the sample size obtained from the first formula will help in getting more precious results than the sample size obtained from the second formula since

the first formula takes in its account the desired variance estimate, but the second formula was calculated with respect to the available budget.

Regarding potatoes crop, the sample sizes of farmers were as follows :

1 - If the desired variance estimated ($V = \frac{d^2}{t^2}$) = .0026, and the assumed cost of obtaining information from one farmer in the stratum = 4 L.E, the sample size equals 2300 farmers.

2 - By ignoring the assumed fixed variance, and using the sample size which depends upon the variable cost, the sample size equals,1800 farmers.

After the ultimale sample size be calculated, the subsequent attrition that accurs over the survey period in the initial sample size has to be taken in consideration. The attrition rate is due

both to respondents deropping out of the sample (for such reasons as lack of cooperation, change of business or locality, and farm failure) and to poor quality data obtained from a portion of those respondents who remained.

Since the survey period for such study will not be too long, 5 percent only of the respondents are expected to be dropped out of the sample.[1] At the same time the poor quality data is expected to be 3 percent on the light of the results of the current pilot study.

So the upward adjustments can be made as follows:

Required Sample size =

$$\frac{\text{Ultimate sample size}}{\text{(Completed interview rate) (Rate of useful data)}}$$

If the ultimale sample size equals 2500 farmers the required sample size equals 2713 farmers.

Finally, the actual sample size must be subject to the time available, and the time needed for traveling among centers and villages. Also, the dominant weather in winter will play an important role in determining the actual sample size.

---

[1] If the survey period is too long (from 12 to 18 month) the rate of dropped out respondents may be as high as 20 percent.

APPENDIX

Table 1

The yield of wheat by centers, 1978-1980

Governorates	Centers		Yield (Ardeb per Feddan)[1]			
	No.	Name	1978	1979	1980	1978-1980 Average
ALEXANDRIA (X)	1	Alexandria	6.83	6.40	5.68	6.30
BEHERAH (B)	2	Abou Homos	7.96	7.80	7.95	7.90
	3	Abou Al-Matamer	8.66	7.96	9.33	8.65
	4	Itay El-Barod	9.66	9.92	10.81	10.13
	5	Hosh Issa	7.86	8.74	8.75	8.45
	6	Delengat	8.25	8.94	9.20	8.79
	7	Damanhour	9.50	8.90	9.31	9.25
	8	Rasheed	7.97	7.11	7.33	7.47
	9	Shobra Kheet	10.59	9.87	9.97	10.14
	10	Kafr El-Dawar	9.37	9.42	9.36	9.38
	11	Kom Hamada	10.89	10.56	10.75	10.73
	12	Mahmodiah	10.47	9.86	9.55	9.97
	13	Rahmaniah	10.28	9.40	9.60	9.77

[1] A Feddan equals 1.04 acres.

Source: Ministry of Agriculture, records of Agricultural Economics Institution.

Table 1 (Continued)
The yield of wheat by centers, 1978-1980

Governorates	Centers		Yield (Ardeb per Feddan)			
	No,	Name	1978	1979	1980	1978-1980 Average
GARBIAH (G)	14	Bassioun	10.22	10.10	9.70	10.00
	15	Zefta	10.58	10.29	10.42	10.43
	16	Samanood	9.31	8.55	9.11	8.92
	17	Santa	10.90	10.25	9.88	10.34
	18	Tanta	11.38	9.01	9.93	10.27
	19	Kotoor	10.52	9.84	9.23	9.86
	20	Kafr El-Zyat	11.06	10.03	9.96	10.35
	21	Mehala El-Kobra	9.30	9.34	10.55	9.71
KAFR AL-SHEIKH, (K)	22	Brolos	4.91	5.90	7.35	6.05
	23	Bialla	9.52	9.58	9.47	9.52
	24	Desouq	10.05	8.94	9.75	9.58
	25	Sedy Salem	8.77	8.66	8.45	8.62
	26	Foah	8.11	8.48	9.09	8.56
	27	Qeleen	9.58	9.19	9.57	9.45
	28	Kafr Al-Sheikh	9.11	8.96	9.05	9.04
	29	Metobas	9.96	8.90	8.82	9.23

Table 1 (Continued)
The yield of wheat by centers, 1978-1980

Governorates	Centers		Yield (Ardeb per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
DAKAHLEEAH (D)	30	Agga	10.12	9.63	10.31	10.02
	31	Belqas	10.17	9.22	10.31	9.90
	32	Dekrns	10.34	8.44	8.17	8.98
	33	Senbelawen	9.30	9.91	9.39	9.53
	34	Sherbeen	10.37	9.43	9.80	9.86
	35	Talkha	8.8	9.85	10.44	9.69
	36	Manzalah	9.16	6.13	7.81	7.70
	37	Mansourah	8.43	8.01	8.64	8.36
	38	Meet Ghamr	10.63	10.00	9.78	10.13
DAMIETTA (T)	39	Damietta	10.01	7.16	9.83	9.16
	40	Faraskour	9.24	8.76	10.27	12.76
	41	Kafr Saad	9.24	8.24	6.97	8.15
SHARKEAH (S)	42	Abou Hamad	10.22	9.85	8.01	9.53
	43	Abou Keber	11.60	8.92	8.04	9.52
	44	Belbes	10.18	9.55	10.37	10.00
	45	Heseniah	7.10	6.61	8.30	7.33
	46	Dierb Negm	9.36	9.96	6.96	8.76
	47	Zagazig	9.94	8.57	11.85	10.12

Table 1 (Continued)

The yield of wheat by centers, 1978-1980

Governorates	Centers		Yield (Ardeb per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
SHARKEAH (S) (Continued)	48	Faqous	9.46	8.63	9.12	9.07
	49	Kafr Sakr	10.78	8.43	8.79	9.30
	50	Menia El-Qamh	10.80	9.62	10.32	10.25
	51	Hehia	10.14	10.52	10.73	10.46
ASMAELEAH (M)	52	Esmaliah	8.51	8.80	8.00	8.43
	53	Tel El-Keber	8.25	7.84	7.75	7.94
	54	Kantra Gharb	6.83	6.49	7.00	6.77
	55	Fayed	10.35	9.83	8.56	9.58
SUEZ (U)	56	Suez	9.19	9.10	9.04	9.13
MENOUFEAH (N)	57	Ashmoun	10.66	10.01	10.25	10.30
	58	Bagour	10.31	9.29	9.64	9.74
	59	Berket El-Sabi	10.82	9.82	9.30	9.98
	60	Talla	9.90	8.50	9.97	9.45
	61	Sheben El-Kom	10.17	9.02	9.33	9.50
	62	Shohada	10.90	9.62	9.59	10.03

Table 1 (Continued)
The yield of wheat by centers, 1978-1980

Governorates	Centers		Yield (ardeb per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
MENOUFEAH (N) (Continued)	63	Qoesna	10.83	9.23	10.19	10.08
	64	Menouf	12.24	11.03	11.37	11.54
QALUBEAH (L)	65	Banha	11.10	10.18	10.27	10.01
	66	Kafr Shokr	12.46	11.43	10.82	11.57
	67	Khankah	8.47	8.03	8.73	8.41
	68	Sheben El-Kanater	10.19	9.48	10.04	9.90
	69	Toukh	12.90	12.02	11.39	12.10
	70	Qalub	11.01	10.31	10.64	10.65
	71	Kanater Al-Khairia	11.45	10.81	10.09	10.78
CAIRO (C)	72	Mataria	9.57	10.32	10.29	10.06
	73	Maadi	9.85	9.97	8.48	9.40
GIZA (Z)	74	Embaba	11.41	10.11	10.50	10.70
	75	Badrashen	11.36	10.88	9.20	10.48
	76	Giza	9.19	8.02	9.47	8.89
	77	Saff	9.31	8.72	9.62	9.21
	78	Aiaat	10.07	9.91	10.45	10.14

Table 1 (Continued)

The yield of wheat by centers, 1978-1980

Governorates	Centers		Yield (ardeb per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
BENY SOUEF (F)	79	Ehnasia	8.22	9.14	8.55	8.64
	80	Beba	8.35	8.52	9.43	8.80
	81	Beny Souef	7.75	7.89	8.68	8.10
	82	Bosh	8.72	8.86	8.00	8.52
	83	Samta	7.60	7.42	7.68	7.60
	84	Fashin	9.40	7.12	7.21	7.91
	85	Wasta	8.64	9.93	9.47	9.34
FAYOM (O)	86	Ebshway	9.82	8.42	8.49	8.91
	87	Etssa	10.42	9.27	8.70	9.46
	88	Senoures	10.61	9.45	9.04	9.70
	89	Temma	8.98	8.03	8.31	8.44
	90	Fayom	10.90	9.49	8.68	9.69
MENIA (E)	91	Abou Qorqas	11.62	10.06	9.90	10.52
	92	Bany Mazar	9.11	8.67	9.41	9.06
	93	Deer Moass	9.52	9.60	9.23	9.45
	94	Samalout	11.43	10.52	10.30	10.75
	95	Adwah	9.84	9.90	7.92	9.22
	96	Mattay	9.59	8.67	8.80	9.02
	97	Maghagha	9.60	9.54	9.60	9.58

Table 1 (Continued)

The yield of wheat by centers, 1978-1980

Governorates	Centers		Yield (Ardeb per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
MENIA (E) (Continued)	98	Mallawy	11.31	10.74	9.91	10.65
	99	Menia	12.13	10.10	10.23	10.83
ASYUT (Y)	100	Abnoub	8.60	9.90	8.75	9.08
	101	Abou Teeg	8.95	11.26	10.14	10.11
	102	Asyut	7.90	9.30	8.49	8.56
	103	Badary	7.94	9.96	9.76	9.19
	104	Sahel Selem	11.58	8.35	9.30	9.74
	105	Dayrout	9.35	10.48	10.17	10.00
	106	Sedffa	7.44	10.17	9.88	9.16
	107	Qousiah	9.48	10.20	9.98	9.88
	108	Manfalout	10.19	9.70	8.21	9.30
	109	Ghanayem	7.45	9.75	10.17	9.12
SOHAG (H)	110	Akhmem	8.40	8.04	10.56	9.00
	111	Awlad Touq	7.01	6.89	7.20	7.03
	112	Baleena	8.90	7.45	8.27	8.21
	113	Gerga	6.50	6.20	7.77	6.82
	114	Saqeltah	6.91	7.91	7.48	7.43
	115	Sohag	8.20	6.50	6.85	7.18

Table 1 (Continued)
The yield of wheat by centers, 1978-1980

Governorates	Centers		Yield (Ardeb per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
SOHAG (H) (Continued)	116	Tumma	9.00	7.86	8.80	8.55
	117	Tahta	8.25	7.04	7.09	7.43
	118	Maraghah	8.00	7.38	8.24	7.87
	119	Mounshaah	6.90	6.38	8.45	7.24
	120	Geheenah	8.46	7.13	7.31	7.60
QENNA (A)	121	Abou Tesht	7.52	7.75	6.07	7.11
	122	Armant	6.99	7.20	7.52	7.23
	123	Essna	6.96	7.17	7.49	7.20
	124	Luxor	8.24	8.24	7.07	7.77
	125	Deshna	6.91	7.12	7.68	7.23
	126	Qenna	7.20	7.42	7.73	7.45
	127	Qouse	7.28	7.50	6.80	7.19
	128	Noqadh	5.31	5.47	6.48	5.75
	129	Nagy Hamady	7.10	7.36	7.60	7.37
ASWAN (W)	130	Edfo	8.10	8.48	7.79	8.12
	131	Aswan	8.73	11.00	8.15	9.29
	132	Kom Ombo	8.00	9.12	8.50	8.54

Table 2

The yield of Potatoes by centers, 1978-1980

Governorates	Centers		Yield (Ton per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
ALEXANDRIA (X)	1	Alexandria	5.56	6.15	5.93	5.88
BEHERAH (B)	2	Abou Homos	4.67	5.64	6.77	5.69
	3	Abou Al-Matamer	4.86	5.45	5.80	5.37
	4	Itay El-Barod	6.72	8.05	8.17	7.65
	5	Hosh Issa	4.57	5.77	6.17	5.53
	6	Delngat	6.03	7.63	8.24	7.30
	7	Damanhour	6.68	6.37	6.20	6.41
	8	Rasheed	7.97	8.04	10.42	8.81
	9	Shobra Kheet	7.22	8.10	7.90	7.74
	10	Kafr El-Dawar	4.75	6.05	6.26	5.68
	11	Kom Hamada	5.62	6.69	6.51	6.27
	12	Mahmodiah	5.93	7.44	7.54	6.97
	13	Rahmaniah	7.43	7.93	6.32	7.23
GARBIAH (G)	14	Bassioun	5.81	6.02	8.17	6.66
	15	Zefta	7.22	7.71	7.81	7.58
	16	Samanood	7.93	8.41	14.65	10.33

Source : Ministry of Agriculture, records of Agricultural Economics Institution.

Table 2 (Continued)

The yield of Potatoes by centers, 1978-1980

Governorates	Centers		Yield (Ton per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
GARBIAH (G.) (Continued)	17	Santa	5.42	7.95	8.03	7.13
	18	Tanta	5.62	6.29	7.37	6.43
	19	Kotoor	4.58	6.44	7.15	6.60
	20	Kafr El-Zyat	5.37	8.21	7.97	7.18
	21	Mehala El-Kobra	5.60	6.66	6.83	6.36
KAFR AL-SHEIKH (K)	22	Bialla	5.69	4.54	5.30	5.17
	23	Desouq	5.53	6.80	7.44	6.59
	24	Sedy Salem	5.66	6.40	6.81	6.29
	25	Foah	6.55	-	7.07	6.81
	26	Qeleen	5.44	7.10	6.20	6.25
	27	Kafr Al-Sheikh	5.96	6.19	6.52	6.22
	28	Metobas	6.66	5.77	8.50	6.98
	29	Hamol	-	4.66	6.40	5.53
DAKAHLEEAH (D)	30	Agga	7.40	7.93	8.30	7.87
	31	Belqas	4.49	7.88	6.73	6.36
	32	Dekrns	6.20	6.70	6.95	6.62
	33	Senbelawen	7.42	7.97	7.19	7.53
	34	Sherbeen	7.11	7.50	6.67	7.93

Table 2 (Continued)
The yield of Potatoes by centers, 1978-1980

Governorates	Centers		Yield (Ton per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
DAKAHLEEAH (D) (Continued)	35	Talkha	6.35	6.94	7.76	7.01
	36	Manzalah	—	—	6.00	6.00
	37	Mansourah	7.17	6.91	7.26	7.11
	38	Meet Khamr	6.85	7.72	7.79	7.45
DAMIETTA (T)	39	Damietta	8.08	6.43	8.47	7.66
	40	Faraskour	8.12	8.76	7.38	8.90
	41	Kafr Saad	6.95	7.05	6.39	6.79
SHARKEAH (S)	42	Abou Hamad	4.00	8.00	6.75	6.25
	43	Abou Keber	8.08	8.86	8.66	8.53
	44	Belbes	5.40	10.85	9.98	8.74
	45	Heseniah	8.53	9.28	8.03	8.61
	46	Dierb Negm	8.28	9.23	8.40	8.63
	47	Zagazeg	8.00	8.70	7.56	8.86
	48	Faqous	7.74	7.74	7.77	7.75
	49	Kafr Sakr	8.20	7.66	8.34	8.66
	50	Menia El-Qamh	6.96	8.12	8.30	7.79
	51	Hehia	7.72	8.54	7.87	8.04

Table 2 (Continued)

The yield of Potatoes by centers, 1978-1980

Governorates	Centers		Yield (Ton per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
ESMAELEAH (M)	52	Esmailiah	5.50	7.60	8.10	7.07
	53	Tel El Keber	6.66	7.77	7.78	7.43
	54	Kantra Gharb	5.50	6.89	6.85	6.41
	55	Fayed	5.64	8.60	5.60	6.61
SUEZ (U)	56	Suez	6.14	6.82	9.00	7.32
MENOUFEAH (N)	57	Ashmoun	5.07	6.93	7.30	6.43
	58	Bagour	6.37	8.20	8.54	7.70
	59	Berket El-Sabi	7.08	7.09	7.22	7.13
	60	Talla	4.96	6.84	6.30	6.03
	61	Sheben El-Kom	6.10	5.60	7.04	6.26
	62	Shohada	6.43	7.57	8.01	7.30
	63	Qoesna	5.40	6.89	6.62	6.32
	64	Menouf	4.78	7.29	7.18	6.41
QALUBEAH (L)	65	Banha	7.40	8.61	9.74	8.60
	66	Kafr Shokr	7.19	7.29	7.73	7.40
	67	Khankah	—	7.56	8.00	7.78
	68	Sheben El-Kanater	8.00	—	8.00	8.00

Table 2 (Continued)
The yield of Potatoes by centers, 1978-1980

Governorates	Centers		Yield (Ton per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
QALUBEAH (L) (Continued)	69	Toukh	6.27	8.98	8.83	8.02
	70	Qalub	7.77	8.12	8.99	8.29
	71	Kanater Al-Khairia	6.60	7.70	7.85	7.38
CAIRO (C)	72	Mataria	5.25	5.50	5.75	5.50
	73	Maadi	8.24	9.69	10.01	9.31
GIZA (Z)	74	Embaba	7.44	8.18	7.19	7.60
	75	Badrashen	7.39	8.29	8.09	7.92
	76	Giza	7.45	—	12.00	9.72
	77	Saff	9.14	7.40	7.29	7.94
	78	Aiaat	7.95	8.48	7.84	8.90
BENY SOUEF (F)	79	Ehnasia	—	4.50	7.29	5.89
	80	Beba	8.21	7.72	6.25	7.39
	81	Beny Souef	7.41	7.20	4.62	6.41
	82	Bosh	7.98	6.15	5.50	6.54
	83	Samta	7.50	7.27	7.79	7.52
	84	Fashin	7.93	8.22	6.57	7.57
	85	Wasta	7.87	6.80	5.80	6.82

Table 2 (Continued)
The yield of Potatoes by centers, 1978-1980

Governorates	Centers		Yield (Ton per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
FAYOM (O)	86	Ebshway	5.50	8.43	7.50	7.14
	87	Etssa	5.00	7.00	5.00	5.66
	88	Senoures	6.00	8.00	7.50	7.16
	89	Temma	6.00	6.00	7.13	6.37
	90	Fayom	5.50	—	6.00	5.75
MENIA (E)	91	Abou Qorqas	6.31	6.75	8.13	7.06
	92	Bany Masar	6.42	5.33	7.75	6.50
	93	Deer Moass	—	6.75	—	6.75
	94	Samalout	5.69	6.17	7.58	6.48
	95	Adwah	5.50	4.60	6.86	5.65
	96	Mattay	5.99	5.80	6.66	6.15
	97	Maghagha	6.51	6.50	8.31	7.11
	98	Mallawy	6.92	6.27	6.43	6.54
	99	Menia	7.41	6.50	6.27	6.73
ASYUT (Y)	100	Abnoub	8.50	9.00	—	8.75
	101	Badary	—	9.00	10.00	9.50
	102	Sahel Selem	—	10.00	—	10.00

Table 2 (Continued)

The yield of Potatoes by centers, 1978-1980

Governorates	Centers		Yield (Ton per Fedaan)			
	No.	Name	1978	1979	1980	1978-1980 Average
ASYUT (Y) (Continued)	103	Dayrout	7.90	—	8.00	7.95
	104	Qousiah	—	9.75	9.00	9.37
	105	Manfalout	8.00	9.91	8.60	8.83
SOHAG (H)	106	Akhmem	8.53	11.49	12.31	10.78
	107	Awlad Touq	—	12.71	—	12.71
	108	Baleena	—	12.50	—	12.50
	109	Gerga	—	—	12.00	12.00
	110	Saqeltah	—	—	12.00	12.00
	111	Sohag	—	12.80	—	12.80
	112	Tumma	7.00	12.67	10.50	10.06
	113	Maraghah	—	12.34	—	12.34
	114	Mounshaah	5.86	11.90	11.52	9.76
	115	Geheenah	—	13.00	—	13.00
QENNA (A)	116	Abou Tesht	—	—	6.00	6.00
	117	Deshna	—	—	6.57	6.57
	118	Qenna	—	6.83	7.86	7.35
	119	Nagy Hamady	7.00	—	5.00	6.00

Table 2 (Continued)
The yield of Potatoes by centers, 1978-1980

Governorates	Centers		Yield (Ton per Feddan)			
	No.	Name	1978	1979	1980	1978-1980 Average
ASWAN (W)	120	Edfo	—	—	8.00	8.00
	121	Aswan	—	—	6.42	6.42
	122	Kom Ombo	—	—	6.00	6.00

BIBLIOGRAPHY

(1) Anderson, David R., Devnis J.Sweeney, Thomas A. Williams, An Introduction to Management Science, Quantitative Approaches to Decision Making, University of Cincinnati, Cincinnati, 1976.

(2) Arrow, K., H.B. Chenery, B.S. Minhas and R.M. Solow. " Capital Labor Substitution and Economic Efficiency, " Review of Economics and Statistics ". August, 1961.

(3) Brooks, S. The estimation of an optimum subsampling number. Jour. Amer. State. Assoc., 1955.

(4) Carter, J.O., and H.W. Hartley. " A Variance Formula for Marginal Productivity Estimates Using the Cobb-Douglas Function ", Econometrica. April, 1958.

(5) Chuta, Enyinna, and Carl Liedholm. " The Role of Small-Scale Industry in Employment Generation and Rural Development: Initial Research Results from Sierra Leone," African Rural Employment paper No. 11, Department of Agricultural Economics, Michigan State University. East Lansing, Michigan 1975.

(6) Cochran, William G., Sampling Techniques, John Wiley & Sons, New York, 1977.

(7) Dahi, Dale C., Jerome W. Hammond, Market and Price Analysis, The Agricultural Industries:, Mc Grew-Hill Book Company, New York, 1977.

(8) Dalenius, T., and Gurney, M. The problem of Optimum Stratification, Jour. Amer. Stat. Assoc., 1951.

(9) Hansen, M.H., Hurwitz, W.N., and Gurney, M. Problems and Methods of the Sample Survey of Business. Jour. Amer. Stat. Assoc., 1946.

(10) Norman, D.W. "Methodology and Problems of farm Management Investigations : Experiences from Northern Nigeria", African Rural Economy working paper, Department of Agricaltural Economics, Michigan State University, East Lansing, Michigan. 1973.

(11) Scherer, F.M., Industrial Market Structure and Economic Performance, Rand Mc. Mally college Publishing Company, Chicago, 1970.

(12) Shepherd, Geoffrey S., Gene A. Futrell, and J. Robert Strain, Marketing farm Products, Iowa State University press, Ames, Iowa, 1976.

(13) Spencer, Dunstan S.C. "The Economics of Rice Production in Sierra Leone, "Bulletin No. 1, Department of Agricultural Economics, Njala University College, Njala, Sierra Leone, 1972.

(14) ——— and Derek Byerlee. "Micro-Analysis of Output, Incomes, and Resource use in Agricultural production in Sierra Leone," African Rural Economy working Paper, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

(15) Tintner, G. Econometrics. Wiley and Sons, New York, 1952.

(16) Tweeten, Luther, Foundations of Farm Policy, University of Nebraska Press, Lincoln, 1970.

======